Pre-Service Teachers’ Views on Simulations in Education: An Interdisciplinary Instructional Development Experience

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Abstract

The aim of this study is to determine pre-service teachers’ views about the process of designing and developing simulations, and contribution of the methodology on their educational experience in an interdisciplinary group work. The sample included 15 Science Education (SE) and 23 Computer Education and Instructional Technology (CEIT) students of 2013 in the 5-weeks summer school. The students were required to design undergraduate level, chemistry-based simulations in a computer simulation environment in interdisciplinary teams. Qualitative data were collected by having participants respond in writing to open-ended questions. Results showed that students not only were satisfied about studying with students from the other department, but also about designing simulations in an interdisciplinary teamwork environment, as they found it an effective instructional method.

Keywords: Simulations; Teacher Education, Interdisciplinary teamwork;

1. Introduction

In the past decade, the growing access to computers, equipment, and software such as computer simulations have become an important part of many science-related educational programs (Rutten, Van Joolingen, & Van der Veen, 2012). Thus, simulations are widely used in science education. A simulation is defined as an interactive abstraction or simplification of some real life situation or any attempt to imitate a real or imaginary environment or system. It is a simulated, real life scenario displayed on computer, which the student has to act upon (Akilli, 2007 p.4). It is a combination of software and hardware to help determine the principles of a real or hypothetical system, usually produced to serve a long life-time with possibly different configurations (Maria, 1997).

The literature indicated that using simulations provide several educational benefits. Stoffa (2004) expressed the

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main reasons for implementing simulation models in education as contribution to student motivation, means to enable more analytic lessons, opportunities to ensure deep learning, support for student activity and creativity, ways that allow realization of animation/simulation experiments, and means for more effective education. Akpan (2001) specifically stated that using simulations in science education has the potential to produce higher learning outcomes in ways not previously possible. In traditional classroom settings, students are often expected to extract knowledge from textbooks prepared by the experts. Using simulations help students more easily construct meanings of science concepts. Students prefer this to the traditional settings (Hoban & Nielsen, 2010). Henning, Lesperance, and Herris (2007) indicate that simulations help students solve problems through critical thinking.

Simulations also can play an important role as a computer-based model of a physical lab. These simulations allow complex experiments without using real equipment (Balakrishnan & Woods, 2013). Students can safely test the variables in the same way as they encounter in real life settings. Simulations can keep students active in any time of the activity by keeping them busy with determining the problem, constructing hypotheses, operating experiments, collecting generated results, note taking, inputting the evaluated data back to computer, and representing data in different ways such as graphs and tables (Huppert, Yaakobi, & Lazarowitz, 1998).

Simulations can more readily satisfy the needs of learners by allowing them various opportunities, repetition and a tool to individually interact with. Students can go over the material multiple times and receive detailed and objective feedback each time (Roh, Lee, Chung, & Park, 2013). Problem-based learning can be considered more effective than the traditional learning, and simulation-based learning can be considered even better than the problem-based learning (Curtin, Finn, Czosnowski, Whitman, & Cawley, 2011).

Apparently, learning is more effective when simulations occur in the appropriate context. In addition to its advantages as a method, when students develop their own simulations, it may more effectively provide deep learning, creative/critical thinking, motivation, socialization, and teamwork skills. However, students need more time and effort, knowledge on the matter, motivation/interest to develop professional level simulations. Such limitations can be eliminated if students study with peers who are subject matter experts. Although research has demonstrated the usefulness of simulation-based instruction in many areas, there is not any research, few if any, examining the efficacy of simulation when students create their own simulations with subject matter experts. Thus, the purpose of this study is to determine Science Education (SE) and Computer Education and Instructional Technology (CEIT) students’ views about the process of designing and developing simulations, and contribution of the methodology on their educational experiences in an interdisciplinary group work. The following research questions were investigated in this study:

1. What are the pre-service teachers’ views about the contribution of the process of designing and developing simulations?
2. What do the pre-service teachers think about the effectiveness of the methodology on their educational experience in an interdisciplinary group work?

2. Method

This study involved students from two different departments in an interdisciplinary study. The study was conducted at the 5-weeks summer school term in 2013.

2.1. Participants

The participants were undergraduate students consisting of 15 pre-service SE teachers (8 females and 7 males) and 25 pre-service CEIT teachers (12 females and 13 males). They were selected using purposive sampling based on convenience. SE students were sophomores and enrolled in an analytical chemistry course and CEIT students were seniors enrolled in an animation-based instructional development course. Naturally, the CEIT students were older than their partners. Mean age of SE and CEIT students were female: $x=20.5$, male: $x=21.28$ and female: $x=21.8$, male: $x=22.53$, respectively. While only four SE students had experience on using simulations before, 21 CEIT students reported experience about simulations.

2.2. Design

First, students were put into groups in their respective courses according to preference. Then, each group was randomly matched with a group from the other department by paying attention to the number of students and gender distributions in each team. Next, the 7 emerging teams were required to design an undergraduate level chemistry simulation in an interdisciplinary teamwork. SE students were asked to identify an analytical chemistry topic and
develop a scenario that provides basic content to CEIT students. Students met during the 2-hour class sections for three weeks and they communicated via cell phones, social network sites, and e-mails in the activity. Some groups also met 1 or 2 extra times. CEIT students developed the computer based simulations with the help of SE students’ facilitation. In brief, SE students took mostly the role of subject matter experts on chemistry and CEIT students were instructional designers and developers during the creation of computer simulations.

2.3. Data Collection

Data were collected using a survey that included 4 demographic questions (department, gender, age, and their experiences in group work) and 10 open-ended questions relating to the key aspects of the study. For the purposes of this research study, the results of the three of the open-ended questions were examined in relation to demographic characteristics: (1) What kind of skills have you gained by working with students from another department during your studies in this course? (2) Has developing animations within interdisciplinary groups been an effective method of instruction? If so, why? And (3) Have you performed any similar activity before?

2.4. Data Analysis

Qualitative data were analysed thematically by the researchers. Two raters coded the data independently. More than one theme could be coded per student response for the first open-ended question. The second open-ended question had a theme which could take three different forms: 2=effective, 1=undecided and 0=not effective. Cohen Kappa inter-rater agreement coefficients for the first and second questions were found to be 0.84 and 0.82, respectively, which are very high. Researcher disagreements were discussed and such codes were resolved.

3. Results

The students rated their interdisciplinary experience in several dimensions. The first question yielded six different themes. Only one of the themes was negative in orientation; all other themes carried positive attitudes. The information below is organized around the student thoughts from the most dominant to the least dominant.

3.1. Student Thoughts on Contributions of the Interdisciplinary Work

Because each student comment could be coded into more than one theme there were a total of 65 potential codes. In Table 1, codes were organized based on department and themes.

Table 1. Themes about the Contributions of the Interdisciplinary Work based on Departments

<table>
<thead>
<tr>
<th>Theme</th>
<th>CEIT (N)</th>
<th>SE (N)</th>
<th>Total (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration, Communication, and Socialization</td>
<td>13</td>
<td>8</td>
<td>21</td>
</tr>
<tr>
<td>Learning Something New</td>
<td>10</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>Learning Better</td>
<td>7</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>General Learning and Professional Development</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Teaching</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>No Benefit</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>27</td>
<td>65</td>
</tr>
</tbody>
</table>

3.1.1. Collaboration, Communication and Socialization: This is the most frequent of the emerging themes for both departments as seen in Table 1. Student comments with meanings such as “I gained coordination skills” “I improved my communication skills” and so on were marked with this theme. Student 6, a SE student indicates, “The study helped us to get fundamental skills such as communication and coordination... The study at least provides progress towards future for people involved, either as social skills or as academic knowledge.” A CEIT student, Student 37, shares his thoughts as “we learned group work and the fact that there are different opinions.” Obviously, the context of the study reached its intended goal for students to benefit from the interdisciplinary work and the most indicative sign was the emergence of this theme, as being the most frequent of all. In other words, the students emphasized collaboration, socialization and communication more than anything else.

3.1.2. Learning Something New: Another major comment was about learning something new. Expectedly, many students benefitted from the fact that they worked with people from different majors. Comments also show the direction of benefit because the CEIT and SE students listed dissimilar benefits. CEIT students emphasized the subject matter role of the SE students and expected them to provide the necessary content. For example, Student 7
says “We learned knowledge on different topics. We learned how to adapt such information to our field of study.” SE students, instead, emphasized the software and technology they dealt with. “We gained broad understanding of the software on which we worked. We learned how to use those programs,” says Student 9.

3.1.3. Learning Better: One of the themes that were more unified across the CEIT and SE students was how the altered course experience has actually improved their learning experience. They considered it a fact that they learn better and produce better materials. Students shared thoughts as such “when my chemistry knowledge and their computer knowledge came together, a simulation with nice and accurate results was formed” (Student 18).

3.1.4. General Learning and Professional Development: Some comments were general in nature. Students sometimes mentioned how the interdisciplinary work enhanced their general skills or skills that can be thought as professional development. The study thought me “research skills and skills for researching with a group” says Student 19. Comments that are similar in meaning to the Student 19’s were coded into this theme.

3.1.5. Teaching: Teaching was more emphasized among the SE students than among the CEIT students probably because of the nature of their role in the assignment. SE students were expected to act in the subject matter expert role and provide their peers with accurate content knowledge. This expectancy was reflected at their thoughts. Even so, the number of codes referring to the teaching aspect was still low.

3.1.6. No Benefit: There were negative comments, as well. Some students indicated they were not able to benefit from the interdisciplinary work. Interestingly, all complaints came from the CEIT students. The complaints were various – some showing no reasons, and some blaming the other group. Student 14, for example, said that, “the experience did not teach me much because we were not able to get much help from the other side.”

3.2. Student Thoughts on the Effectiveness of the Interdisciplinary Work

The second open-ended question was coded to be one of the three options. 29 out of 40 thought the process was quite an effective method for learning the content. 16 CEIT students and 13 SE students were positive. SE students were more optimistic about the experience. Student thoughts such as the following were coded effective:

Yes, because the material to be developed to be content-wise right and beneficial, the topic should be presented in highest care. For that to happen, getting the upmost level theoretical support is necessary. The friends who were the subject matter experts provided that to happen (Student 10).

The comment was one of CEIT students’, reflecting the principals they learn in the course in terms of the qualities of instruction and the ways to obtain it. A SE student reflected that:

Yes, it was effective because the visual memory is always stronger and more effective than the textual memory. (This activity,) provided the opportunity to transfer the knowledge in a more beneficial and permanent way to the student by emphasizing the difference between listening to the content and seeing the content (Student 13).

Some of the students were undecided about the effectiveness. It would actually be more precise to claim that such students emphasized both effective and ineffective aspects of the interdisciplinary work. Out of seven such students, five were CEIT students. Student 17 for example commented that “it is effective in theory, but when it came to application, factors such as the following prevented the theory to be transferred to the application as originally intended: the summer school term, the lack of course hours, constraints to meet, and so forth.” The fact that all students who found the work ineffective were CEIT students was one of the most interesting takeaways. There were four such students. Most such thoughts were accompanied with the comment that the students could not get the intended support from the other department. Student 15 from CEIT, for example, indicated “our friends could have given us more detailed information but because the groups could not much meet at the class hours, it remained inaccessible. We researched the topic on our own and completed the project based on that.”

4. Conclusions and Discussion

It would be meaningful to articulate that when pre-service teachers develop their own simulations in an interdisciplinary team environment, their instructional development is impacted in many ways. One of the most important ways was how the study contributed to their experiences. With respect to the interdisciplinary team work on designing and developing simulations, while only 3 of the 40 pre-service teachers thought that the study has not been worthwhile, majority of them (92.5%) stated that it has been an effective study. Although not directly related with the process of developing and designing simulations, Collaboration, Communication and Socialization theme was of the highest interest – it would rather be concerned with the nature of the interdisciplinary work. The results concur with Oncu and Ozdilek (2013) in that students were satisfied to be part of an interdisciplinary study since
they benefitted from meeting with new people.

The second highest interest of student themes regarding the first research question was Learning Something New (n=17). CEIT students specifically mentioned that they enhanced their knowledge on chemistry topics and similarly SE students learned about the simulation development software. Meanwhile, CEIT students were aware that they would not be able to design simulations that were accurate content-wise otherwise, as they were not knowledgeable about the undergraduate chemistry topics – neither would they be expected to. They appreciated, at first hand, the role of the subject matter expert in the design process. SE students gradually watched their ideas take shape and were excited to see the capabilities brought by the software.

Within contributions of the interdisciplinary study, an average consideration was given to the improved learning experience through the design and development process of simulations. This result is also consistent with the benefits of simulation technique identified by other researchers including ensure deep learning and more effective education (Stoffa, 2004) and gaining higher learning outcomes (Akpan, 2001). This consideration gives the SE students the responsibility to master the chemistry content and CEIT students to possess skills on the simulation development software to better facilitate their partners, assuring the success of the collective product. Accordingly, the study stimulated SE students to do research and learn the topic meticulously as they were required to act in the subject matter expert role and provide their peers with accurate content knowledge, which is to teach the chemistry topic. With the express of their motivation, they stated that they needed time and they had to make effort to learn how to use the simulation program. Because they find the simulations quite an effective instructional technique, the SE students expressed interest in designing their own simulations when then they become in-service teachers.

Although some of the students were undecided about the effectiveness of the work, as mentioned earlier, majority of them stated that the study was worthwhile for learning the content in their respective courses as they had to design and develop their own simulations. The reason for CEIT students to think the study was not effective might be the lack of communication and motivation among the team members; because they specifically stated that they could not find sufficient time to meet except for the class hours and that the SE students were unable to teach chemistry scenarios to them.

In sum, the study was worthwhile for students to share knowledge and experiences with each other, develop skills on working in groups, socialize, and enhance knowledge on chemistry topics and simulation development software. Overall, the study proved an effective, and hands on instructional design activity where students from two different departments performed tasks that are expected of them in the real world contexts.

References